Mining fatty acids from algae

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A trip to the doctor for an annual physical usually includes the measurement of cholesterol and triglycerides, the latter part of the lipid family. High readings are considered to be a potential danger to one's health. However, not all lipids are dangerous.

Significance

Lipids play a variety of roles in life—they make up the membranes that surround cells, they are involved in signaling for cell growth, inflammation, immunity and reproduction. And they are an excellent source of energy for living organisms.

Scientists at Los Alamos National Laboratory and the University of Washington are exploring the use of lipids for energy: as a starting material for creating biofuels. Some species of algae naturally produce lipids in abundance, making them a desirable feedstock for lipid-based fuels. These strains of algae live in both saltwater and fresh water environments and if they are carefully cultivated, they could be coerced into making enough lipids to fuel automobiles and planes.

Given the value of energy stored in lipids, much research as been dedicated to investigating the use of lipids for diesel fuel or other routes of energy production. The research team at Los Alamos and the University of Washington targeted the genome of a less-studied algae strain called *Chrysochromulina tobin, a "*Haptophyte*"* which is known to be a prolific producer of lipids. The team wanted to learn more about this strain's lipid production and potential for use in biofuels. However, in addition to learning about lipids, they found new antimicrobial compounds produced by the algae, and proteins that are sensitive to light and might be used to control cells in living tissues.

Research achievements

In order to understand how *C. tobin* could be used to produce lipids for fuel, the research team sought to understand more about its natural lipid production processes. The team studied lipid production over a 24 hour period of day and night, and sequenced the genome and the transcriptome (which is made up of the messenger RNA molecules) of *C. tobin*. The objective of this study was to determine the link between the day-night cycle and the production of the lipids, and to see if they could understand which genes are being used to make the lipids. The team discovered that lipid production was tightly regulated by two distinct groups of genes. The first pathway, which builds the individual fatty acid molecules, displayed genes that were

up-regulated during the day. The second pathway combines individual fatty acids to form triacylglycerols, which are high-energy storage molecules. Genes in the second pathway were found to be up-regulated during the night.

“By knowing which genetic pathways are used when the cell is producing the most lipids will help us optimize lipid production for biofuels efforts,” said Blake Hovde, a postdoctoral researcher at Los Alamos.

Armed with this information, the team can embark on a thorough understanding of how lipid production is regulated, and therefore how to modify the pathways to increase it. Since lipids are an excellent source of energy, making genetic modifications in the algae to maximize lipid production is one objective that could significantly impact the viability of lipid-based biofuels.

This method of sequencing and evaluating transcriptome data is useful for many types of research, but the Los Alamos team has been using it for biofuel applications, sequencing many different algae strains to learn about the best way(s) to grow algae.

The research team

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Reference: “Genome Sequence and Transcriptome Analyses of *Chrysochromulina tobin*: Metabolic Tools for Enhanced Algal Fitness in the Prominent Order Prymnesiales (Haptophyceae).” ***PLOS Genetics***; published online September 23, 2015; doi: 10.1371/journal.pgen.1005469.

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Caption for image below: *C.tobin utilizes a long appendage, called a haptonema, to capture bacterial prey for consumption. Photo by Chloe Deodato, University of Washington*